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riod of almost ten years. For these reasons, when he was leaving Japan, he was decorated with the third order of the Rising Sun, and was also appointed honorary head professor of the engineering college.

In 1882 the art school was discontinued. In 1885 the Department of Public Works was abolished,—an event which caused the college to be transferred to the control of the department of education.

In the late Tōkyō Daigaku and Kōbu Daigakkō, the following degrees were conferred on the graduates by their respective authorities: *Hōgakushi* in the department of law, *Rigakushi* in science, *Igakushi* in medicine, *Bungakushi* in literature, and *Kōgakushi* in engineering.

On the 1st of March, 1886, the Imperial Ordinance No. 3 was promulgated for the organization of the Teikoku Daigaku, or Imperial University, and the Tōkyō Daigaku and Kōbu Daigakkō were merged in the new institution. H. E. Hiromoto Watanabe, then the governor of Tōkyō, was appointed president of the university. In April, curricula of instruction for the several colleges of the university were established. Each course extends over three years, excepting the course in medicine, which extends over four years. In the same month the Tōkyō Shokkō Gakkō (School of Industrial Technology) was placed under the control of the university. In November the five principal private law schools in the city were placed under the supervision of the university. A supervising committee for these schools was formed among the professors of the College of Law, who became responsible for the courses of instruction and the method of examining the students. In December of the same year a marine zoological station was established at Misaki, a town situated at Cape Miura, in Sagami.

In May, 1887, the Imperial Ordinance No. 13 was promulgated, establishing regulations for learned degrees; and in June of the same year by-laws connected with these regulations were issued by the minister of state for education. In July it was decided that graduates of the colleges should be entitled to call themselves *Hōgakushi*, *Igakushi* (*Yakugakushi* in the case of graduates in the course of pharmacy), *Kōgakushi*, *Bungakushi*, and *Rigakushi* respectively, according to the course which they had pursued; and that *Jun-igakushi* of the Tōkyō Daigaku, and graduates of the Kōbu Daigakkō who had not received degrees, should be allowed to call themselves *Igakushi* and *Kōgakushi* respectively, after obtaining the sanction of the president of the university, to whom a formal application must be made, and a history given at length of their professional career after graduation.

In October the Tōkyō Shokkō Gakkō was separated from the university. In March, 1888, the powers and duties of the president of the university were formally fixed by the minister of state for education. In the same month a notification was issued by the education department, regulating the income, from tuition fees and various other sources, of all educational institutions under the direct control of the department, with the object of supplying each with a capital fund. In May the university was released from the duty of supervising the five principal private law schools in Tōkyō.

The Tōkyō Observatory was established at Iigura in the month of June. This institution, formed by the amalgamation with the University Observatory, of the Astronomical Section of the Home Department and the Astronomical Observatory of the Imperial Navy, was placed under the control of the Imperial University, which was accordingly intrusted with the duty of publishing the Astronomical Almanac.

On July 31 the College of Engineering was moved to the new brick building just completed for its use in the compound at Hongō. On the 30th of October of the same year a temporary committee for the compilation of the national history was established. This was due to the disestablishment of the temporary board for the compilation of the national history in the Naikaku, and to the subsequent intrusting of the work to the Imperial University. On the 20th of December of the same year the College of Science was removed to the new building then completed.

The Imperial University is under the control of the minister of state for education, and depends for its revenue upon annual

allowances from the treasury of the Imperial Government. The tuition fees and other sources of income are allowed to accumulate year by year, so as to form a large fund. A certain portion of this fund is, however, to be paid out in some cases towards the current expenditure of the university, when the cases are of such a nature as to demand the outlay.

The whole university—viz., the offices of the university, the university library, the colleges of law, medicine, engineering, literature, and science, the First Hospital of the College of Medicine, and the dormitories of the colleges—is situated in the extensive grounds at Motofujichō, Hongō, Tōkyō, known as Kagayashiki. The Botanic Garden is located at Koishikawa, the Tōkyō Observatory belonging to the university at Iigura, and the Second Hospital of the Medical College at Shitaya, all within the city limits. The Marine Biological Station of the university is situated at Misaki, a town on the north side of the entrance to the Bay of Tōkyō.

#### THE CHEAPEST FORM OF LIGHT.<sup>1</sup>

THE object of this memoir is to show, by the study of the radiation of the fire-fly, that it is possible to produce light without heat other than that in the light itself, that this is actually effected now by nature's processes, and that these are cheaper than our industrial ones in a degree hitherto unrealized. By "cheapest" is here meant the most economical in energy, which, for our purpose, is nearly synonymous with "heat;" but, as a given amount of heat is producible by a known expenditure of fuel at a known cost, the word "cheapest" may also here be taken with little error in its ordinary economic application.

We recall that in all industrial methods of producing light there is involved an enormous waste, greatest in sources of low temperature, like the candle, lamp, or even gas illumination, where, as has already been shown, it ordinarily exceeds 99 parts in the 100; and least in sources of high temperature, like the incandescent light and electric arc, where yet it is still immense, and amounts, even under the most favorable conditions, to very much the larger part.

It has elsewhere<sup>2</sup> been stated, that, for a given expense, at least one hundred times the light should in theory be obtainable which we actually get by the present, most widely used methods of illumination. This, it will be observed, is given as a minimum value; and it is the object of the present research to demonstrate that not only this possible increase, but one still greater, is actually obtained now in certain natural processes, the successful imitation of which we know of nothing to prevent.

It is now universally admitted that wherever there is light there has been expenditure of heat in the production of radiation, existing in and as the luminosity itself, since both are but forms of the same energy; but this visible radiant heat which is inevitably necessary is not to be considered as waste. The waste comes from the present necessity of expending a great deal of heat in invisible forms before reaching even the slightest visible result; while each increase of the light represents not only the small amount of heat directly concerned in the making of the light itself, but a new indirect expenditure in the production of invisible calorific rays. Our eyes recognize heat mainly as it is conveyed in certain rapid ethereal vibrations associated with high temperatures, while we have no usual way of reaching these high temperatures without passing through the intermediate low ones; so that, if the vocal production of a short atmospheric vibration were subject to analogous conditions, a high note could never be produced until we had passed through the whole gamut, from discontinuous sounds below the lowest bass, up successively through every lower note of the scale till the desired alto was attained.

There are certain phenomena, long investigated yet little understood, and grouped under the general name of "phosphorescent," which form an apparent exception to this rule, especially where

<sup>1</sup> Abstract of an article by S. P. Langley and F. W. Very, published in the American Journal of Science for August, 1890.

<sup>2</sup> See results of an investigation by S. P. Langley, read before the National Academy in 1883, and given in Science for June 1, 1883, where it is shown that in the ordinary Argand burner gas-flame indefinitely over 99 per cent of the radiant energy is (for illumination purposes) waste.

nature employs them in the living organism; for it seems very difficult to believe that the light of a fire-fly, for instance, is accompanied by a temperature of 2000° F. or more, which is what we should have to produce to gain it by our usual processes. That it is, however, not necessarily impossible, we may infer from the fact that we can, by a known physical process, produce a still more brilliant light without sensible heat, where we are yet sure that the temperature exceeds this. No sensible heat accompanies the fire-fly's light, any more than need accompany that of the Geissler tube; but this might be the case in either instance, even though heat were there, owing to its minute quantity, which seems to defy direct investigation. It is usually assumed, with apparent reason, that the insect's light is produced without the invisible heat that accompanies our ordinary processes; and this view is strengthened by study of the fire-fly's spectrum, which has been frequently observed to diminish more rapidly toward the red than that of ordinary flames.

Nevertheless, this, though a highly probable and reasonable assumption, remains assumption rather than proof, until we can measure with a sufficiently delicate apparatus the heat which accompanies the light, and learn not only its quantity, but, what is more important, its quality. Apart from the scientific interest of such a demonstration, is its economic value, which may be inferred from what has already been said. It therefore seems desirable to make the light of the fire-fly the subject of a new research, in which it is endeavored to make the bolometer supplement the very incomplete evidence obtainable from the visible spectrum.

As we may learn from elementary treatises, phenomena of phosphorescence are common to insects, fishes, mollusks, vegetables, and organic and mineral matter. Among luminous insects the fire-fly of our fields is a familiar example; though other of the species attain greater size, and perhaps greater intrinsic brilliancy, especially the *Pyrophorus noctilucus* Linn., found in Cuba and elsewhere. Its length is about 37 millimetres, width 11 millimetres, and it has, like *Pyrophori*, three light-reservoirs,—two in the thorax, and one in the abdomen. To procure this Cuban fire-fly, the aid of the Smithsonian Institution was sought, and through the kindness of Professor Felipe Poey of Havana, and Señor Albert Bonzon of Santiago de Cuba, in the Island of Cuba, living specimens of the *Pyrophorus noctilucus* were received during the summer of 1889.

After a preliminary spectral examination in Washington, it was found more convenient to continue the research at the Allegheny Observatory by means of the very special apparatus supplied by the liberality of the late William Thaw of Pittsburgh, for researches in the lunar heat-spectrum. Photometric measurements throughout the spectrum of the insect's light were also made.

Resuming, then, what we have said, we repeat, that nature produces this cheapest light at about one four-hundredth part of the cost of the energy which is expended in the candle-flame, and at but an insignificant fraction of the cost of the electric light or the most economic light which has yet been devised; and that finally there seems to be no reason why we are forbidden to hope that we may yet discover a method (since such a one certainly exists, and is in use on the small scale) of obtaining an enormously greater result than we now do from our present ordinary means for producing light.

## HEALTH MATTERS.

### Female Medical Students in India.

THE study of medicine is becoming very popular with the native women of India. At the close of the academic session in 1889, says the *Medical Record*, there were 24 female students at the Calcutta Medical College, 14 at the Campbell Medical School, and 5 at the Cuttack Medical School. At Agra, during the year, 7 young women received licenses to practise. At Lahore there were 19, and at Madras 39, female medical students, one of the latter being the first to take the degree of M.B. at the Madras University. There were also female students at the Grant Medical

College of Bombay, and at the Government Medical Schools at Poonah, Ahmedabad, and Hyderabad. The movement was initiated a few years ago by Lady Dufferin, the wife of the Viceroy of India. Madame Pim, a diplomated surgeon from Paris, has settled down in Bangalore, and is doing a large practice among the Zenana ladies there. A Bangalore paper believes that there is ample room for a lady surgeon or two in the Mysore Province, and it is said that the Maharajah will offer a scholarship to any girl student of the Maharanee's College who cares to enter on a course of medical study at the Madras Medical College. It is also stated in the *Indian Medical Gazette* that a large number of female pupils at the Agra Medical School have just passed their final examinations. These include several students who were especially sent by the Durbars of Ulwar and Tezpur and the municipalities of Etah, Fyzabad, and Raipur.

### Treatment of Diphtheria.

In the *Répertoire de Pharmacie* for July 10, 1890, it is stated that Dr. Babchinski was attending a case of grave diphtheria occurring in his own son, in which a rapid change for the better occurred coincidentally with the appearance of erysipelas on the face. The fever rapidly fell, the false membrane disappeared, and cure rapidly took place. Dr. Babchinski also states (*The Therapeutic Gazette*) that in several other cases he noted a great improvement coincident with the appearance of erysipelas, and in one of them the erysipelas occurred on the leg, and not on the face. These facts suggested to Dr. Babchinski the idea of inoculating diphtheria cases with blood taken from patients suffering from erysipelas, and he states that in several cases in which he employed this procedure cure resulted. Later on, he practised inoculation of other cases of diphtheria with cultures of the microbe of erysipelas in agar-agar, and likewise noticed the disappearance of the symptoms of diphtheria. He further adds, that, when the inoculations were made, all special treatment was suspended, and in no case did the erysipelas present any sufficient gravity to cause uneasiness. He concludes by stating, that, if his observations and experiences are confirmed, this treatment should rob diphtheria of all its dangers.

### The Work of a Health-Officer.

Dr. Frank W. Wright, the health-officer of New Haven, in his annual report just issued, expresses himself on some important points as follows:—

"In making this report, I feel that I should express the opinion that it is the duty of the Board of Health to take as active measures to preserve the good health of the community as it does to suppress the spread of disease after it has made its appearance. I know that public sentiment is directly opposed to any progress, and always will be until sickness and death have caused serious havoc; and then the cry will go forth, 'Why has the Board of Health done nothing to prevent this?'

"It is urgently demanded, in justice to yourselves and by all who wish to have our city regarded as a sanitary locality, that your board should see that a proper bill is introduced before the next Legislature, more fully defining your powers, and granting power to you in such directions as seems to you necessary for the preservation of the public health.

"The code of plumbing laws now pending before the Court of Common Council, if adopted, will be a step in the right direction. I firmly believe that more sickness is caused in this city by poor plumbing than by any other single condition. This is proved by the fact that the death-rate is larger every month in those wards where the prevailing plumbing is rusted-out sheet-iron pipes, loose joints, and untrapped sinks, than in those wards where the plumbing is generally good. I have carefully prepared a comparison of the three wards where the plumbing is the poorest with the three wards that have the best plumbing. As the wards representing poor plumbing, I have taken the third, fourth, and seventh. For the year ending Nov. 30, 1889, the death-rate per thousand was 20.6, 16.4, and 20.8 respectively. In the wards representing good plumbing, the first, eighth, and tenth, the death-rate per thousand for the same year was 7.9, 12.8, and 13.1 respectively. To any fair-minded person this must be convincing."